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good, no *Phytophthora* being visible anywhere. There was, however, a blight of the foliage that has proved very general and widespread throughout all this region. The leaves turned yellow in spots, then brown, and the entire vines died long before the growing season was completed. The check rows in the experimental plat and my own potatoes elsewhere on my farm were all seriously affected with this blight. By the first of September this was so emphatic that the check rows were easily selected from the plat, the treated vines showing mostly bright and green when frost came. Still there was an occasional hill among the treated vines showing the same trouble as the untreated, but not in so large a degree.

We had expected to use our field pump in a large barrel mounted on farm trucks with the Vermorel nozzle attached to the hose, but found that we could not go over the plat and make the turns with the team without running into the potatoes and injuring them. So we abandoned its use and did the entire work by hand with our Nixon Climax pump, using a No. 3 Nixon nozzle. We overcame the difficulty of clogging by having a piece of brass wire strainer cloth soldered over the lower end of the suction pipe. This had a mesh finer than the orifice of the nozzle and was a complete remedy for clogging, not only in using the Bordeaux mixture, but also in all other spraying done by us.

Another variation we made was in using the Bordeaux mixture. We hauled out for each treatment a barrel containing 12 pounds each of copper sulphate and lime and 44 gallons of water properly mixed to make the regular Bordeaux mixture. We also took another barrel of clear water. At the beginning we stirred the mixture, allowed it to settle a minute, and took out two or three pailfuls to use. After using enough for the southwest corner, clear water was added to the large barrel, and so on until the plat was gone over, 70 to 75 gallons in all being used. This would give about the following strength nominally to each plat: Southwest, full strength; southeast, two-thirds; northeast, three-fourths; northwest, one-half. There was, however, about the same appearance in the consistency of the liquid used for each plat on account of the sediment in each lot being about all the water would carry, and the appearance of the vines after spraying was the same in each plat. From the time of the first spraying the application was always more or less visible. I thought there was a difference in the vigor of the vines in favor of the northeast corner, but suppose the figures as tabulated by Professor Goff will show this matter clearly. At any rate I venture the opinion that it may be well to experiment with Bordeaux mixture in a more diluted form than the regular formula.

Another apparent result of the spraying was in regard to the Colorado potato beetle. I found it necessary to go over the check rows with London purple the second time, but the treated part was almost entirely free from them. It would thus appear that where the mixture is used for rot and blight it may also be efficient as an insecticide.

DISEASES OF THE ORANGE IN FLORIDA.*

By LUCIEN M. UNDERWOOD.

The following notes on the diseases of the orange in Florida were made during a visit to that State during the months of February, March, and April of the present year (1891). They consist simply of the results of observations in the field and evidence collected from intelligent growers in various portions of the State. The orange groves and methods of cultivation and treatment were observed in the following counties: Brevard, Citrus, Hernando, Lake, Manatee, Marion, Orange,

* Professor Underwood collected the information embodied in this report while acting as special agent for the Division of Vegetable Pathology.—[B. T. G.]

Pasco, Polk, St. John's, Volusia. Nine other counties were traversed and visited during the winter.

GENERAL CONSIDERATIONS.

(1) The cultivation of the orange in America is of comparatively recent origin. The very oldest groves in Florida do not reach a half century, and there are few groves of even half that age. As the orange trees do not usually show disease until they reach full bearing it is natural to suppose that the absence of diseases in certain localities is due to the fact that the groves are too young to show the effects of disease; it is also natural to expect that as the groves grow older certain diseases will become more and more prevalent. Certain it is that the greatest ravages of disease are to be seen among the oldest groves.

The fact that the orange industry is comparatively a new one is the cause of much injury to many orange groves because of lack of experience in cultivation and fertilization.

The method and time of cultivation are an important matter for orange-growers. Judging from observation in many places there is more of a tendency in the direction of overcultivation than the reverse. Moreover, the method, time, and extent of application of fertilizers are exceedingly important, as well as the adaptation of the kind of fertilizers used to the varying conditions and necessities of the soil. Much injury results to groves by (a) overcultivation and (b) unfortunate treatment with fertilizers in quantity, quality, and method of application.

Unfortunately for the orange-growers the State experiment station is located too far north to be within the belt of profitable orange-growing. There is pressing need of more organized experimental work in this direction in order to attain the best method of treatment and thus avoid many of the causes of injury from the sources above mentioned.

(2) There exists in Florida a great diversity of soil and a large proportion of the State is not adapted to orange-culture. In fact, only a few favored localities are likely to long maintain their reputation for the cultivation of citrus fruits. Many groves now planted will never reach maturity, or, if so, will require more artificial fertilizing to mature a crop than will be profitable to the owner. One source of disease is the starved condition of certain groves, owing to natural deficiencies of soil, for weakened vitality increases the liability to become the prey of organic troubles.

(3) Many orange groves were started in regions where the trees are subjected to low temperature during the winter months. Even where frosts do not kill the young twigs outright the vitality of the tree is much weakened by the effect of either a cold snap or continued cold weather, and consequently more likely to be preyed upon by organic diseases. The great frost of 1886 and the unexpected late frosts of 1890 and 1891 (occurring in March in the former and in April in the latter year) have left their marks on the orange groves in many quarters, not

merely in external and visible manifestations, but even more in the impaired vitality of the orange trees. It may be added that some of the effects of frosts are not infrequently confounded with diseases of a very different nature.

(4) The exceedingly dry season of the past year has also left its traces in the impaired vitality of many trees, and the uncertainty of rain and the liability of drought are inducing many to introduce irrigation plants, which in the hands of careless cultivators are likely to become a source of harm as well as good.

CLASSIFICATION OF DISEASES.

The diseases affecting the orange may be arranged under four groups:

(1) Those resulting from climatic conditions and environment, as frost, drought, natural defects of soil, natural excesses of soil constituents, and undue moisture.

(2) Those produced by insect pests. Although this group is outside the limits of this paper, we may mention in passing that during the present season the long scale,* the red spider,† and the rust mite‡ are apparently the most troublesome pests of this nature, but the first is likely to be kept in check by the lady bugs (*Coccinellidae*), the second will succumb to spraying, and the third may be held in check by the character of the cultivation.

(3) Those due to injurious cultivation and fertilization.

(4) Those due to the agency of parasitic fungi and bacteria.

Only the diseases of the last two groups will receive notice here. The diseases noticed during the early season of 1891 were as follows:

- I. Die-back.
- II. Foot-rot. } Probably caused by improper cultivation or fertilization.
- III. Blight. Possibly caused by bacteria.
- IV. Scab.
- V. Leaf spot. } Caused by parasitic fungi.
- VI. Sooty mold. Caused by a saprophytic fungus.
- VII. Leaf glaze. Caused by a leaf lichen.

I.—DIE-BACK.

(1) *Nature of the disease.*—This disease first makes its appearance in strong shoots of the season in the form of pustules or blisters on the stems near the point of attachment of the leaves. These when opened appear to contain a reddish, gummy substance. In later stages of the disease these pustules rupture and extend in cracks along the twig, the reddish gummy substance coming to the surface and spreading until the whole twig becomes diseased and finally dies back to the main stem. This peculiar and characteristic effect gives rise to the appropriate, if not elegant, popular name of the disease. In badly infected trees most or all of the fruit falls when young; that which matures is likely to be mis-shapen and discolored. There seems to be no evidence that the disease is contagious.

Trees that have been affected with die-back and have recovered from its effects will reveal it years afterward in the sudden bends of the

* *Mytilaspis gloverii*, Pack. † *Tetranychus telarius*, L. ‡ *Typhlodromus oleivorus*, Ashm.

smaller branches. The main twigs die and the smaller side branches, having taken up the growth and received the nourishment intended for the main branch, become larger and appear as if the branches had taken sudden turns in the process of their growth.

(2) *Distribution.*—The disease does not seem to have occasioned much alarm, although it appears to be widespread and liable to occur whenever the causes that produce it are present. Bad cases of it occur in various portions of the orange belt visited.

(3) *Causes.*—It is the almost universal testimony of growers that excess of nitrogenous fertilizers will either produce the die-back, or, what is equivalent, will produce the conditions under which the disease will develop. The evidence collected in the field bearing on this point justifies a similar conclusion.

Among others the following conditions, under which the disease is prevalent, point to this source of the difficulty :

- (a) Proximity of orange trees to horse stables or piles of horse manure.
- (b) Proximity of trees to houses where, with the carelessness induced by the porous sandy soil, household slops are thrown indiscriminately.
- (c) Proximity of trees to chicken pens. The habitual roosting of poultry in orange trees is likewise liable to induce the disease. In several groves visited it had been the former custom to use portable chicken pens which were moved from tree to tree in order to secure a natural guano in the place where it was supposed to be most beneficial. In all these cases the practice had been stopped because of the die-back that appeared in every tree thus fertilized. The trees had not recovered at the time of our visit.
- (d) The excessive use of blood and bone or other commercial fertilizers rich in nitrogenous elements seems to stimulate the disease.

(4) *Remedies.*—Almost as general as the belief in the cause or occasion of this disease is the belief that the most effectual remedy is to let the affected trees entirely alone. The cessation of cultivation and heavy fertilizing will remove the disease even in bad cases. We noticed trees, which two years ago produced no fruit, because of the severity of the disease, that were sufficiently restored to produce a half crop or more during the present season, with no other treatment than that above mentioned.

II.—FOOT-ROT.

(Gum disease, *mal di goma.*)

(1) *Nature of the disease.*—This disease has long been known in Europe and has also given rise to some investigations in this country. Mr. A. H. Curtiss has quite fully described the disease, and we quote from his description :

The prominent symptoms are exudation of a gummy or sappy fluid from near the base of the trunk, and decay of the bark in that region and of the roots below. The flow of gum and attendant decay of the tree extend upward and in a lateral direction until the tree is girdled, also penetrating successive layers of wood. In some cases gum exudes from cracks in various parts of the trunk or even on the branches, and in others the decay progresses without emission of gum. Attendant or premon-

itory symptoms are excessive and rather late blooming, the flowers being small or mostly unfruitful, and arrested and unnatural development of the foliage, which becomes yellow and drops.*

We could gain no evidence of its contagious nature. A résumé of information concerning this disease has been already published from the Department,† and only such additional or conflicting information as we have gathered will be here given.

(2) *Distribution*.—Like the preceding disease, foot-rot is not confined to particular localities, but has a wide distribution. Bad cases occur at various points throughout the orange belt; it is more serious in the older trees, rarely appearing in trees less than 12 or 15 years old. In many places, especially in young groves, it is just beginning to appear, but has not yet attracted the attention it merits, for as groves grow older and present methods of fertilization continue it is likely to prove still more injurious and destructive. Contrary to popular and published opinion, it is not confined to sweet seedlings. We have seen bad cases in large sour stock budded 2 or 3 feet above ground, in the grape fruit, and even in the lemon.

(3) *Causes*.—Nothing has come to light that settles upon any definite cause for the disease. From all that can be learned, however, it would seem that the cause is to be looked for in the defects of cultivation and fertilization rather than in any bacterial or fungous parasite. Some maintain that it is of a similar nature to die-back and is occasioned and cured by the same treatment. There is no visible proof of this statement and no facts to illustrate any genuine cures, as in the case of the former disease; it is doubtful if more than temporary relief can be gained by this method, for when the disease is well established in the tree it is almost certain to girdle it in time in spite of any treatment yet discovered.

(4) *Remedies*.—Sweet seedlings affected by this disease are frequently assisted by planting one or more stands of sour nursery stock near the root and budding several branches into the trunk above the infected portion. This at best can furnish only temporary and partial relief, for the disease is likely to spread too rapidly in the main trunk to allow the budded support time to furnish sufficient nourishment for the tree before its own supply is cut off, or the sour stocks are likely to be ultimately affected themselves.

Exposing the crown roots is another method of treatment in favor in certain parts. As a preventive it is more likely to be successful than as a cure, but it is doubtful if this method will be of any permanent value and there is some liability of its proving an injury to the trees in other ways. One method of treatment connected with the manner of cultivating the trees seems worthy of trial: Cultivate sparingly, fertilize more sparingly, and apply no fertilizer nearer than 6 or 7 feet

* Bulletin No. 2, Florida Agr. Experiment Station, 1888.

† U. S. Department of Agriculture, Botanical Division, Bulletin No. 8, pp. 51-54 (1889).

from the trunk of the tree. In addition a study should be made of the relative adaptability of the various fertilizers to the particular soil. This is properly the function of public experimenters, but much can be accomplished by individuals if sufficient care is exercised. In one of the finest groves visited the principal fertilizer used consisted of decaying vegetable rubbish piled between the rows of trees. Weeds were allowed to grow in the intervening spaces thus covering the light-colored soil, and preventing much of the undue reflection of light and heat that is so common where clean culture is practiced.

III.—BLIGHT.

(LEAF CURL, WILT, GO-BACK.)

(1) *Nature of the disease.*—The leaf blight, leaf curl or leaf wilt, as it is variously called, first makes its appearance on certain branches, and may be recognized by the curled or wilted appearance of the leaves, which also turn a sickly yellowish color and after a short time drop from the tree. The twigs at the ends of the branches also die, and if new ones appear they soon present the same sickly hue; the bark, especially on the upper side of the branches, becomes "hide-bound," and later splits open on either side, leaving a dead space between the ruptures. The fruit grows smaller, but is otherwise not affected. Gradually other branches become infected, and if the tree is left to itself it finally dies down to the root. As the disease progresses new shoots constantly make their appearance below the infection, appearing robust at first, but as the infection descends they too become wilted, and finally those only appear healthy that spring from the root. If the tree is vigorously pruned at the first appearance of the disease and well fertilized, it will apparently recover, but after a little will relapse or go back to its former condition. This peculiarity of the disease has given rise to a popular name which it does not seem desirable to perpetuate.

The disease does not seem to attack trees before they reach maturity, or before they are 10 or 12 years old. When one tree becomes attacked, adjoining trees, either during the same season or more likely during the following season, will be affected, so that the diseased trees appear in groups. Sporadic cases occasionally occur, but the above condition is so nearly universal as to make it extremely probable that the disease is contagious.

(2) *Distribution.*—Bad cases of this disease are found as yet in only a few localities where the orange groves have long been established. While it is evidently not a new disease its ravages have only recently extended sufficiently to give alarm to cultivators. All things considered, this disease is the most dangerous that has yet appeared among the orange groves, and a study of its causes and cure demands immediate attention.

(3) *Causes.*—Nearly as many causes are assigned for the disease as there are cultivators whose groves are affected by it. Some assign it

to the decay of tap roots and others to the tap root coming in contact with hard pan or underlying rock formation. To test this the tap roots of certain infected trees were exposed and examined. The tap root extended about 4 feet in one case and between 8 and 9 feet in another, and in every case had not extended below the sandy soil and were apparently healthy. Some attribute it to overbearing; still others, to some peculiar oiliness of the soil which prevents it from becoming thoroughly wetted. In regard to this we may state that, while the surface is usually very dry in most locations, the subsoil in all the examinations made on infected trees was wet and in one case water accumulated in the excavation at a level only a foot below the extremity of the tap root. Others liken the disease to pear blight. It differs, however, from that disease, in extending to parts of the same tree much more slowly and in spreading to trees adjacent to the center of the infection only after a considerable time, usually after the interval of a season's growth.

From all the evidence gathered in the field we incline to the belief that this disease is bacterial in its nature, and while the evidence is so scanty as only to create an *impression* it is strong enough to recommend investigation in the direction of this theory. With sufficient time (because the action of the disease is rather slow) a skilled experimenter could doubtless prove its nature to be bacterial, if such be the case. The other causes assigned and probably still others connected with the methods of cultivation, and possibly some climatic conditions, may indirectly encourage the spread of the disease by furnishing conditions under which the tree can not successfully resist the attack of the disease. It is well known, but too often not sufficiently taken into account, that certain physiological conditions render trees subject to ravages of disease, just as among men and other animals, and often a disease may be warded off by keeping the tree in the proper condition of vitality, more easily than it can be cured if once the disease has taken possession of it.

(4) *Remedies.*—There is little to say under this head at present. The following methods have been tried, but with indifferent success :

- (a) Prying up the trees, so as to raise the roots from the "hard pan."
- (b) Cutting back the branches and fertilizing heavily.
- (c) Trimming off affected branches and burning them.
- (d) Trimming back branches, trenching at a distance of six or eight feet from the tree, so as to cut back roots proportionally, followed by heavy fertilizing.

In addition to the above, a rather unique method of treatment was applied by the advice of a dealer in a commercial fertilizer "specially adapted to the cure of diseased trees." This consisted of cutting back all the branches of the tree to within two or three feet of the trunk, smearing the cut ends of the branches with coal tar as a preventive against the ravages of the "crown borer,"* and then smearing the entire

* *Elaphidion inerma* Newman.

trunk with a paste made of clay, lime, sulphur, and "chips" (dry cow manure). At the time of our visit the application had only recently been made, so we were not able to see the results. It can hardly be expected that such a treatment will prove beneficial. The same dealer claims to have cured a number of trees in that way, but at the time of our visit to his place he was absent from home and we were thus unable to sift the evidence.

IV.—SCAB.

(1) *Nature of the disease.*—This disease first makes its appearance in the form of whitish or cream-colored spots, more commonly on the under side of the leaf but often on the upper side and occasionally on the young twigs and fruit. Those on the leaf are often accompanied by a depression or pit on the opposite side. These spots grow larger and often coalesce; ultimately they turn dark, and if abundant the leaf becomes badly curled, twisted, or otherwise distorted and more or less covered with the wart-like eruptions which the disease has developed.

(2) *Distribution.*—The disease is widespread; in a few localities it does not seem to be regarded as anything serious. In other localities, where it is more abundant, it is becoming the source of much alarm. It is not confined to young trees, but attacks equally young and old stock. While more abundant on the wild orange it is by no means confined to it, nor even to sour stock. We saw it on wild orange trees very commonly, on grape fruit and lemon trees frequently, and on sweet orange trees rarely.

(3) *Causes.*—Prof. F. L. Scribner, who made a study of this disease in 1886,* attributed it to a parasitic fungus (a species of *Cladosporium*), whose growth in the tissues of the leaf produced the distortions and saps its vitality. Our own observations confirmed these conclusions.

(4) *Remedies.*—In the paper above alluded to Prof. Scribner makes the following recommendations for spraying mixtures: (a) A solution of potassium bisulphide, one-half ounce to the gallon; (b) liquid grisin; (c) one-half pint carbolic acid and 1 pound of glycerine added to 10 gallons strong soap suds.

We could not learn that these remedies or any other treatment had been attempted in any of the orange regions visited.

V.—LEAF SPOT.

(1) *Nature of disease.*—On certain leaves of the orange, both wild and sweet, faded spots appear, varying in shape, but mostly rounded or oval, and in size from one-eighth of an inch to an inch in diameter. As the disease progresses, these spots become grayish brown and dead, and covered on one or both surfaces with a series of minute black points, which contain the fruit of the fungus, which is the cause of the disease.

* Bulletin Torrey Botanical Club, XIII, 181-183 (Oct., 1886).

(2) *Distribution*.—This disease was found at only one point in Lake County. Dr. Martin found it in 1886 at Green Cove Spring. It does not seem to be widespread nor at present of much importance, but is recorded here that attention may be called to it, so that its nature may be known and its progress watched.

(3) *Causes*.—The cause of this disease is a parasitic fungus (*Colletotrichum adustum*, Ellis)* which draws the nourishment from the leaf it inhabits. It belongs to a group of fungi that are known to be imperfect forms, and are supposed to be a phase of growth in the life history of some mature form of fungus. The particular form of which this species is a phase of growth is not known nor even suspected. Its connections are to be looked for among some of the many species of ascomycetous fungi which inhabit decaying vegetable matter, and for this reason are supposed by the uninformed to be of no economic interest.

VI.—SOOTY MOLD.

(1) *Nature of the Disease*.—The leaves of certain trees badly affected with some kind of scale insects become covered with a sooty layer, which is of a dark drab or dirt color early in its growth and finally becomes sooty black. The layer thus formed is only loosely attached to the smooth surface of the orange leaf and frequently comes off in patches.

(2) *Distribution*.—This disease does not appear to be very widespread on the orange trees in Florida† and the material collected was young and immature. We found it, however, more abundant on *Magnolia foetida*, *Smilax* sp., and other shrubs which were abundantly affected with scale insects.

(3) *Causes*.—In 1876 Dr. W. G. Farlow published an elaborate paper‡ giving a full account of this disease as affecting the orange and olive trees of California, and referring it to a fungus (*Capnodium citri*, Berk. & Desm.) which feeds on the honey dew produced by the bark lice. While the fungus draws no nourishment from the orange leaves themselves it must, if abundant, seriously interfere with the process of assimilation and therefore be regarded as injurious.

(4) *Remedies*.—In the paper above mentioned, spraying with a strong solution of alkali soap is recommended. The disease has not yet made sufficient progress in Florida to demand much treatment, and with the natural enemies of the scale insect to check their development is not likely to prove a serious difficulty.

* Described as *Phyllosticta adusta*, E. & M., but Mr. Ellis (*In litt* 16 May, 1891) refers it to *Colletotrichum*.

† At Los Angeles, California, in 1886, we saw this disease in great quantity, entirely covering the leaves in some of the orange groves. With the disappearance of the scale insect the disease will disappear likewise.

‡ Bull. Bussey Inst. 1, 404-414, 1876.

VII.—LEAF GLAZE.

The disease to which we have given the above name makes its appearance in the form of grayish flattened patches on the upper surface of the leaves. These are small and often clustered at first, but soon coalesce and become of considerable size. The spots are due to the growth of a lichen (*Strigula* sp. probably *S.complanata*, Fee.), which draws no nourishment from the leaves but, like the preceding disease, must interfere in a measure with the assimilation of the plant. Many other lichens and some scale mosses (*Hepaticæ*) are likely to accumulate on the trunks and branches of the orange trees where there has been careless management of the groves. Their presence is a disadvantage to the tree as harboring places for vermin, but they are much less likely to have any influence over the physiological functions of the tree than the present species. We are not aware that attention has been called to this source of trouble before in relation to the orange trees nor that any methods of treatment have been recommended for arresting the growth of the lichen. Tuckerman reports this species on *Magnolia*, and we found it abundant on *Magnolia* leaves in Lake County. The spots of growth on the orange were small and immature at the time of our visit, but as the rainy season advances they are said to increase in extent and often spread over considerable portions of the leaf.

OTHER FUNGI GROWING ON ORANGE TREES.

Only a few species of saprophytic fungi were found among the orange groves, growing on dead or dying trunks and on dead limbs and twigs. The two species of *Hypochnus*, whose systematic position is uncertain, grow on the trunks of living trees that are usually more or less covered with lichens and *Hepaticæ*. The following were found, some not being in a condition to be specifically identified: *Schizophyllum commune*, *Polyporus* sp., *Corticium* sp., *Hypochnus albo-cinctus*, *H. rubro-cinctus*, *Xylaria* sp., *Diatrypella citricola*, Ellis, n. sp., *Macrosporium*, sp., and some others of still more doubtful relations.

PEACH BLIGHT.

Monilia fructigena, Persoon.

By ERWIN F. SMITH.

(Plates V and VI.)

This note is for the purpose of calling renewed attention to the destructive action of *Monilia fructigena* upon the branches of the peach. It will serve to record some new facts and to correct one or two assumptions which found their way into a previous paper * without sufficient warrant.

* *Journal of Mycology*, vol. v, No. 3.